PRICE BEHAVIOR OF PAPER AND PAPERBOARD INDUSTRY

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DEDICATION

I would like to dedicate this work to my parents and my wife

for their love, support, patience, and encouragement.

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LIST OF ABBREVIATIONS

VAR	Vector Autoregressive Model
LPM	Liner Probability Model
Probit	Probit Model

ABSTRACT

This paper presents a model of the probability of price response to the previous period's inventory absolute and relative level for U.S. paper and paperboard industry. The initial part of the paper contains a theoretical analysis of the phenomenon. The proposed framework indicates that the inventory level plays an important leading role in the price adjustment.

The model is then estimated with monthly data extending from 1980 to 1999. The LPM and Probit models are used to estimate the effect of absolute and relative inventory level on the probability of price variations. The estimated results are in agreement with the oligopolistic market condition of U.S. paper and paperboard industry, showing the price upward adjustment is "sticker" and rigid than the price downward adjustment while the output level is indifferent to the previous month's inventory fluctuation.

1. INTRODUCTION

There have been a tremendous number of studies documenting the dynamics of product market behavior. The literature on dynamics has concentrated mainly on the product market that is capable of describing the short-run dynamic behavior of price, output and inventory.

Darling and Lovell (1965) show that firms determine the optimal level of inventories with the rate of production taken as given and with price held constant. Similarly, Eckstein and Fromm (1968) show that price formation is under the assumption that the rate of production has been predetermined and the level of inventories is often ignored. However, Hay (1970) finds empirical support to include price as the decision variable because firms do exercise some control over price and would use their current pricing policy to select the specific price-quantity combination that best contributes to their overall schemes of profit maximization. There is also important evidence against inventory-free specifications provided by the law of supply and demand. The main evidence is presented by McCallum (1974) in terms of the price adjustment models based on supply-of-storage inventories theory and its application to the U.S. lumber industry. To be more precise, Maccini (1976) develops a theoretical framework that isolates and emphasizes the role that the dynamic forces of inventory adjustments and price expectations play in the process. In particular, he provides a theoretical rationale for the inclusion of the price expectation as a direct determinant of the process of price formation.

Illuminated by the existing theoretic framework and empirical studies, although limited, Blinder (1982) investigates the relationship between inventories and sticky prices, the principal finding is that both price and output responses become smaller as demand shocks become less persistent and output becomes more “inventoriable.” As the economy has been subject to economic shocks and to high variable levels of inflation, the issue of relative price dispersion has raised the prominent interest, Amihud and Mendelson (1982) present a new derivation of the relationship between the relative price dispersion (RPD) across industries and the variance of aggregate economic shocks, which relies on the inventory adjustment policies of firms. Combining the theoretical framework of capital asset pricing model and the empirical result that the optimal price response of firms to the realized levels of their inventories is negative, they derive a microeconomic inventory adjustment model that the RPD is an increasing function of the variance of aggregate demand and supply shocks, as well as of the variances of the industry-specific shocks. They suggest that RPD is induced by the inventory adjustment policies of firms. Economic shocks may affect each industry’s inventories to a different extent, inducing a price response that again may vary across industries. This leads to the proposed relationship between the variance of the aggregate shocks and the variance of relative price dispersion. In addition, Aguirregabiria (1999) examines the interaction between price and inventory decisions in retailing firms and its implications for the dynamics of markups and the existence of sales promotions. Using a panel data of a supermarket chain in terms of the fixed-effects probit model that employs the inventory at the beginning of the month, the retail wholesale price, and the markup at the beginning of the month as explanatory variables, as well as includes monthly dummies to control for aggregate shocks, the estimation of the model shows that the inventory level has significant effect on the probability of both types of nominal regular retail price adjustments. When the inventory is large the firm tends to reduce the nominal retail price, but when the inventory starts to decrease price increases become more likely.

While econometric analyses of sectorial price variations have been made for a number of industries in recently years, few attentions have been given in the paper industry. To help economists gain a better understanding of the pricing mechanisms of paper related industries, Dagenais (1976) presents a model of price determination for newsprint in eastern North America and shows that the necessity for the price leader to lower his price, in times of lower operating rate, in order to prevent excessive temptations for other mills to undersell, seems convincing. Furthermore, Booth, Kanetkar, Vertinsky and Whistler (1991) find evidence confirming the existence of barometric price leadership with oligopolistic coordination that depends on commonly used pricing rules in the North American news print industry, where the leader merely provides the anchor for price calculations and adjustments and/or signals the results of such an adjustment to the fringe. They find that a model based on the assumption of industry wide pricing rule using either a mark-up over marginal cost or adjusted full-cost pricing provided predictions consistent with the data. The OLS estimation shows support for a mark-up that is a function of the operating rate in the industry suggesting that tacit coordination is less effective in the periods of weak markets. They also find evidence of price rigidities indicating the need for some form of signaling to induce firms to adjust their prices to changing market conditions. The model also shows that higher concentration levels led to reduced levels of capacity expansion, indicating some weak coordination.

As the research has been extended to the paper and paperboard industry, Muller (1978) presents a basic structure of an econometric model specified in a manner reflecting the oligopolistic nature of the Canadian pulp and paper industry and discussed the performance of the model in some simulation experiments reflecting the effect of cost increases due to environmental controls and of other exogenous variables. Inspired by the previous research studies, Buongiorno and Lu (1989) show that a mark-up pricing model has given plausible results for U.S. data with an inventory-output ratio variable serving as signal for price change. Most recently, Christensen and Caves (1997) analyze the structural conditions governing investment rivalry in the North American pulp and paper industry. To investigate the sensitivity of the current profitability of any capacity expansion to overall capacity utilization, which arises from prices that appear flexible and sensitive to capacity utilization, they undertake a simple analysis of a panel of nine paper products from 1970 to 1991, regressing the price on the price of market pulp, average hourly earnings of production workers in paper mills, a nonlinear function of the rate of capacity utilization for that product, and product fixed effects. Their OLS estimation shows that prices vary closely with short-run marginal costs when capacity utilization is below 93 percent but rise rapidly as capacity grows more fully utilized.

Based on the above studies, the purpose of this paper is to present a discrete choice model of price determination for U.S paper and paperboard industry. We estimate the effect of previous month's inventories, inventory-sales ratio and inventory-capacity ratio on the probability of price increases or decreases as well as on the probability of output increases or decreases. Comparing the relative probability of price versus output changes, we are able to gain some insights to the degree of price and output flexibility in response to short-run market conditions and industry climate.

The paper is organized as follows. In Section 2, we outline an econometric framework for the price behavior models. Section 3 briefly describes the data. Section 4 discusses the empirical results based on LPM estimation and Probit estimation. Section 5 concludes.

2. A SIMPLE ECONOMETRIC FRAMEWORK

In the U.S. paper and paperboard industry, the number of firms with significant market shares and the presence of a large number of fringe companies has molded the oligopolistic coordination within the market, which specified five basic conditions: (1) small number of firms with significant market shares but too large for any of them to be an effective price leader, (2) severe barriers to entry, (3) a relatively homogeneous product, (4) price elasticity not much above unity, and (5) similarity of costs among firms. The coordination emerged as the form that the leader acts only to legitimize the price that reflects the underlying price calculations of the dominant incumbents. The leader provides an anchor for the calculation of the other firms in the industry and a trigger for price adjustments of incumbents. The leader's price will signal to the market price reductions through off-list price concessions, or signal price adjustments upwards to reflect changes in improved demand conditions. Price coordination is achieved through gradual adjustments by the large incumbents to new market conditions with the fringe firms acting as price takers.

It has been observed that the market conditions across industries are determined by the variance of aggregate economic shocks, which relies on the inventory adjustment policies of firms. This finding has posited a strong link between the price behavior and inventory adjustment of the U.S paper and paperboard industry.

It is well established by now that the oligopolists alter the price at regular points of time based on the change of demand conditions and avoid frequent price changes because any change in price might signal defections in the informal agreement on prices and thus cause a loss of monopoly profits. Therefore, the model of price behavior mechanism must be based upon specifications of demand and supply functions for the U.S. paper and paper board industry, let these be given by

(1) $D_t = \beta P_t + \varepsilon_t$

(2) $Q_t = \gamma P_t + u_t$

where D_t is the demand for period t, Q_t is the supply for period t, P_t is the price for period t, and both ε_t and u_t are disturbance terms.

Now we consider several models that explicitly recognize holdings of inventories. In each case the underlying hypothesis is the same that inventory levels are related to current and anticipated future prices. The implied relationship, together with those describing price expectation and production cost behavior, is used to generate a product supply function that takes into account inventory adjustments, which approximate those of present value maximizing firms. Price levels in all periods are those that equate the resulting industry supply with market demand. The different models result from alternative assumptions regarding price expectations.

The key relation between the price and inventory states that, for a present value maximizing competitive firm, the optimal level of inventory to hold at the end of a period is that at which the marginal cost of inventory holding equals the price change expected between current and the succeeding period. Symbolically, the optimality condition can be written as

(3) $P_{t+1}^{e} - P_t = \lambda(I_t)$

where P_{t+1}^{e} is the price expected for period $t+1$, I_t is the level of inventory carried from t into $t+1$, and λ is a marginal inventory holding cost function.

In practice, P_{t+1}^{e} is not given, so an operational version of the theory requires several assumptions regarding price expectations. For the moment, we focus on the familiar adaptive expectations formula,

(4) $P_{t+1}^{e} - P_t = \varphi(P_t - P_t^{e})$

We also assume that λ can be approximated with a linear function,

(5) $\lambda(I_t) = \alpha_0 + \alpha_1 I_t$

Using these assumptions, the market clearing condition $D_t = Q_t + I_{t-1} - I_t$ can be written as

(6) $\beta P_t + \varepsilon_t = \gamma P_t + u_t + I_{t-1} - (1-\varphi)[I_{t-1} - (1/\alpha_1)(P_t - P_{t-1}) - \varphi\alpha_0 / \alpha_1(1-\varphi)]$

where the expression for I_t is obtained by eliminating P_{t+1}^{e} from (3), (4) and (5).

Equation (6) can be solved for P_t. Letting $\eta = \alpha_1 /(1-\varphi)$ and $\rho = 1 + \eta(\gamma - \beta)$, the result is

(7) $P_t = \dfrac{-\alpha_0\varphi}{\rho(1-\varphi)} + \dfrac{1}{\rho} P_{t-1} - \dfrac{\eta\varphi}{\rho} I_{t-1} + \dfrac{\eta}{\rho}(\varepsilon_t - u_t)$

or more simply,

(7’) $P_t = \theta_0 + \theta_1 P_{t-1} + \theta_2 I_{t-1} + \omega_t$

Simply transforming the equation (7’), we can obtain

$$(8) \qquad \Delta P_t = \pi_0 + \pi_1 I_{t-1} + \mu_t$$

Thus, the price to be set for period t depends on the level of inventory at the end of the previous period. In practice, the price behavior also reflects a cyclical fluctuation as a consequence of seasonality throughout the year. This can be represented as including monthly dummies into the equation (8), therefore, we can obtain

$$(9) \qquad \Delta P_t = \pi_0 + \pi_1 I_{t-1} + \pi_2 Jan + \pi_3 Feb + \pi_4 Mar + \pi_5 Apr + \pi_6 May$$
$$+ \pi_7 Jun + \pi_8 Jul + \pi_9 Aug + \pi_{10} Sep + \pi_{11} Oct + \pi_{12} Nov + \mu_t$$

where December is the base group.

The economics behind our result indicates that inventories may transmit aggregate economic shocks into prices together with the seasonal fluctuations; consequently the price leader in the industry may response to these economic disturbances in terms of cooperative pricing to catch up with the change in market condition.

3. THE DATA

Monthly data from January 1980 to December 1999 were collected for this study. The statistics sources for this analysis are obtained from '*AFPA Statistics for Time Series Analysis: 1980-1999'* (United States, 2000). Descriptive statistics are reported in Table 1.

Table 1. Descriptive Statistics

Variables	Description	Mean	STDV	Minimum Value	Maximum Value
Price	U.S. linerboard price, in US$ per thousand short tons	347.48	63.08	250.00	530.00

Price Change	1 indicates U.S. linerboard price increase compared to previous period, 0 otherwise	0.12	0.33	0.00	1.00
Output	U.S. linerboard output, in thousand short tons	1,606.50	309.01	925.00	2,224.00
Output Change	1 indicates U.S. linerboard output increase compared to previous period, 0 otherwise	0.53	0.50	0.00	1.00
Inventory	U.S. linerboard inventory, in thousand short tons	1,895.59	209.09	1,305.40	2,336.60
Sales	U.S. linerboard output excluding inventory, in thousand short tons	1,388.43	261.28	737.80	1,933.80
Inventory/ Sales Ratio	U.S. linerboard inventory divide U.S linerboard sales	1.41	0.27	0.92	2.73
Capacity	U.S. linerboard capacity, in thousand tons	1,702.59	306.30	1,141.94	2,304.66
Inventory/ Capacity Ratio	U.S. linerboard inventory divide U.S linerboard capacity	1.14	0.17	0.79	1.69

To gain some insights on the structure of the series, figure 1 displays the pattern of U.S. linerboard price and absolute inventory level. From the visual inspection, we can see that those two series move with the identical trends while it appears that the inventory series plays a leading role with approximately one period ahead. It is also shown that the absolute inventory level is consistently increasing from 1980 to 1999, which may be the consequence of ever-growing industry capacity. Therefore, although the trend inspection proves that the inventory is an appropriate estimator for the price response, its endogenity may result in the estimation bias. In order to solve this issue, we further look at the series of the absolute industry capacity and sales level.

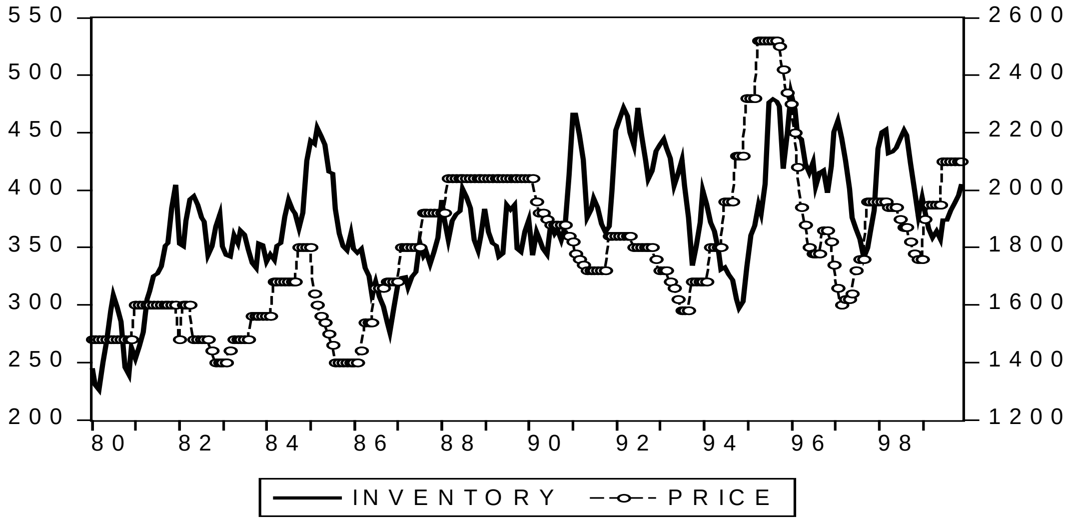

Figure 1. The U.S. linerboard price and inventory pattern, 1980-1999

As shown in Figure 2, it is found that the industry capacity and sales are increasing in line with the inventory level, which partially uncover the cause of the endogenity of the inventory. Based on those finding, it indicates that the relative ratio between inventory and capacity or sales may be better estimators because that will eliminate the endogenity of the absolute inventory level.

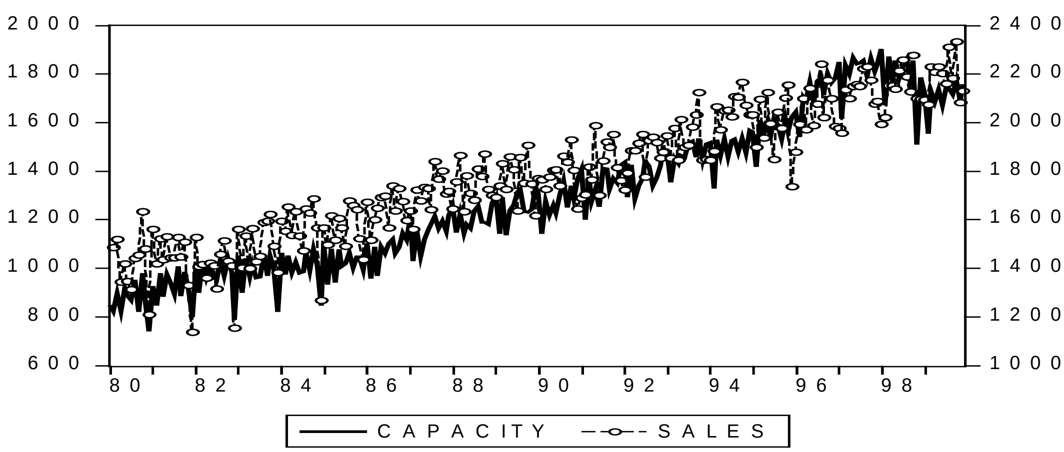

Figure 2. The U.S. linerboard capacity and sales pattern, 1980-1999

4. EMPIRICAL RESULTS

In the absence of long-term equilibrium relations between price and inventory, inventory-sales ratio or inventory-capacity ratio, a study on short-term interactions is in order. We apply the Granger (1969) model, based on the following bivariate VAR model:

$$(10) \quad \Delta P_{1t} = \alpha_0 + \sum_{i=1}^{k} \alpha_{1i} \Delta P_{1t-i} + \sum_{i=1}^{k} \alpha_{2i} \Delta I_{2t-i} + \varepsilon_{1t}$$

$$(11) \quad \Delta I_{2t} = \beta_0 + \sum_{i=1}^{k} \beta_{1i} \Delta P_{1t-i} + \sum_{i=1}^{k} \beta_{2i} \Delta I_{2t-i} + \varepsilon_{2t}$$

where P_{1t} denotes the price of linerboard and I_{2t} denotes the inventory, inventory-sales ratio or inventory-capacity ratio, and ε_{1t} ε_{2t} are assumed to be serially uncorrelated with zero mean and finite covariance matrix. When the null hypothesis $H_0 : \alpha_{21} = \alpha_{22} = ... = \alpha_{2k} = 0$ is retained, it suggests that I_{2t} does not Granger-cause P_{1t}. Conversely, if the null hypothesis $H_0 : \beta_{11} = \beta_{12} = ... = \beta_{1k} = 0$ is not rejected, it implies that P_{1t} does not Granger-cause I_{2t}. The main problem with the use of Granger-Causality test is to identify the number of lags included in the model. Different criteria, such as likelihood ratio statistics, finite prediction error, Akaike, Schwartz, and Hannan-Quinn criterion, often point out at different lag length and consequently lead to contradictory results. We choose to use the SIC criterion since it tends to point out the most parsimonious models.

A perusal of Table 2 reveals that inventory, inventory-sales ratio and inventory-capacity Granger-cause price changes, but not vice versa. In contrast, the output is found to lead inventory, inventory-sales ratio and inventory-capacity ratio but there exists weak reverse causal relationship. The results of Granger test justify our econometric model that uses inventory related variables to estimate the price behavior but imply that we have to apply the same approach to estimate the output to complement our theoretical framework.

Table 2. Granger-Causality Test

	H_0: Price does not Granger-cause Inventory	H_0: Inventory does not Granger-cause Price
F statistics	15.37	27.83
P value	.01%	0%
	H_0: Price does not Granger-cause Inventory-Sales Ratio	H_0: Inventory-Sales Ratio does not Granger-cause Price
F statistics	.48	12.76
P value	62.1%	0%
	H_0: Price does not Granger-cause Inventory-Capacity Ratio	H_0: Inventory-Capacity Ratio does not Granger-cause Price
F statistics	.21	9.94
P value	81.1%	0%
	H_0: Output does not Granger-cause Inventory	H_0: Inventory does not Granger-cause Output
F statistics	3.67	3.24
P value	2.7%	4.1%
	H_0: Output does not Granger-cause Inventory-Sales Ratio	H_0: Inventory-Sales Ratio does not Granger-cause Output
F statistics	13.29	1.31
P value	0%	27.1%
	H_0: Output does not Granger-cause Inventory-Sales Ratio	H_0: Inventory-Sales Ratio does not Granger-cause Output
F statistics	19.16	3.57
P value	0%	3.0%

Based on the Granger-Causality test results, we start to examine the effect of previous month's inventory related variables on the probability of price change and output change, which are dichotomous having value "1" when the current price or output level increases from the previous month and "0" when it decreases and keeps unchanged. Although the Probit is an efficient and consistent estimator for the discrete choice behavior, it is lack of complementary approach to account for the auto correlation issue. While the LPM estimation can cross verify the estimated results after it controls the heterscadasticity with the robust standard error and serial correlation with the Cochrane-Orcutt approach, we apply both LPM and Probit models to estimate those two dependent variables based on equation (9). To account for the cyclical shock throughout the year, we add monthly dummy variables in the model. The estimated results are reported in Tables 3-14.

Table 3. Results on the price increase response to the absolute inventory level

	Price Increase							
	Lag 1		Lag 2		Lag 3		Lag 4	
	LPM	Probit	LPM	Probit	LPM	Probit	LPM	Probit
Inventory[1]	-.111**	-.147***	-.065	-.124***	-.040	-.090*	-.003	-.032
	(-2.34)	(-4.10)	(-1.47)	(-3.10)	(-.94)	(-1.90)	(-.09)	(-.51)
January	.052	5.419	.058	5.217	.066	4.923	.095	4.945
	(.86)	(4.81)	(.81)	(4.78)	(.91)	(4.52)	(1.41)	(8.07)
February	.117	5.718	.147	5.614	.152	5.220	.157	5.191
	(1.66)	(5.09)	(1.68)	(4.94)	(1.70)	(4.72)	(1.97)	(8.84)
March	.280	6.247	.290	6.127	.308	5.804	.316	5.716
	(2.85)	(5.58)	(2.67)	(5.41)	(2.70)	(5.13)	(3.10)	(10.20)
April	.115	5.700	.1211	5.572	.127	5.245	.153	5.208
	(1.62)	(5.10)	(1.50)	(4.96)	(1.51)	(4.62)	(1.92)	(8.91)
May	.017	-	.015	-	.005	-	.000	-
	(1.12)	-	(.80)	-	(.34)	-	(.02)	-
June	.034	5.111	.042	5.014	.055	4.671	.067	4.590
	(1.75)	(4.37)	(1.84)	(4.23)	(1.96)	(3.91)	(1.46)	-
July	.172	5.885	.188	5.764	.192	5.450	.200	5.380
	(2.00)	(5.26)	(1.99)	(5.13)	(2.01)	(4.78)	(2.35)	(9.49)
August	.050	5.521	.080	5.314	.091	4.987	.099	4.937
	(1.43)	(4.76)	(1.18)	(4.67)	(1.29)	(4.36)	(1.54)	(8.16)
September	.033	5.087	.024	5.010	.033	4.623	.046	4.564
	(1.45)	(4.35)	(.95)	(4.20)	(.73)	(3.93)	(.98)	(8.16)
October	.284	6.209	.292	6.114	.295	5.800	.300	5.689
	(2.86)	(5.57)	(2.67)	(5.39)	(2.69)	(5.01)	(3.06)	(10.26)
November	.023	4.990	.024	4.946	.023	4.646	.050	4.586
	(1.23)	(4.42)	(.96)	(4.25)	(.76)	(3.91)	(1.07)	(6.90)
Constant	.215	-3.810	.125	-4.278	.080	-4.681	.006	-5.66
	(2.33)	-	(1.46)	-	(.93)	-	(.09)	(-4.65)

Note: *, **, *** = significant at 0.10, 0.05 and 0.01 level.

Evidence from Table 3, the response of linerboard price increase to previous one-month's inventory is significant for both LPM and Probit models, lying in the range from

[1] We reported marginal effect of inventory related variables in table 3-14 instead of normal coefficient for the probit model

–0.111 to –0.147 while that of linerboard price increase to previous two and three-month's inventory are only significant for probit model resulting from the unaccounted serial correlation.

Table 4. Results on the price increase response to the inventory-sales ratio

	Price Increase							
	Lag 1		Lag 2		Lag 3		Lag 4	
	LPM	Probit	LPM	Probit	LPM	Probit	LPM	Probit
Inventory/Sales	-.046*	-.142***	.052	-.084**	-.013	-.070*	-.009	-.024
	(-1.71)	(-3.77)	(1.34)	(-2.10)	(-.18)	(-1.79)	(-.27)	(-.52)
January	.048	5.566	-.016	5.077	.071	4.923	.101	4.967
	(1.47)	(6.18)	(-.36)	(7.27)	(.53)	(7.75)	(1.52)	(8.07)
February	.136	5.729	.779	5.565	.209	5.288	.159	5.201
	(1.60)	(6.58)	(12.66)	(7.11)	(1.31)	(7.91)	(2.01)	(8.76)
March	.291	6.272	.309	5.957	.321	5.958	.318	5.752
	(2.73)	(7.12)	(2.19)	(8.42)	(1.54)	(8.21)	(3.17)	(10.24)
April	.134	5.576	.150	5.426	.145	5.317	.168	5.283
	(1.71)	(6.71)	(1.44)	(7.37)	(.88)	(7.74)	(2.13)	(8.94)
May	.000	-	-.007	-	.002	-	.002	-
	(.03)	-	(-.36)	-	(.07)	-	(.13)	-
June	.011	4.850	-.022	4.753	.011	4.610	.048	4.604
	(.46)	(5.65)	(-.67)	(6.11)	(.21)	(6.11)	(1.05)	(6.87)
July	.146	5.753	.176	5.477	.172	5.465	.195	5.380
	(1.61)	(7.01)	(1.50)	(8.31)	(.98)	(8.20)	(2.32)	(9.36)
August	.029	5.439	.052	5.078	.062	4.956	.093	4.958
	(.89)	(6.18)	(.66)	(7.17)	(.54)	(7.50)	(1.47)	(8.12)
September	.038	4.923	.002	4.842	.291	4.685	.058	4.582
	(1.55)	(5.68)	(.05)	(6.02)	(6.48)	(6.25)	(1.30)	(6.85)
October	.274	6.043	.291	5.800	.287	5.826	.297	5.708
	(2.55)	(7.48)	(2.15)	(8.91)	(1.41)	(8.57)	(3.08)	(10.19)
November	.006	4.745	-.000	4.682	.015	4.591	.044	4.605
	(.25)	(5.77)	(-.01)	(6.27)	(.26)	(6.42)	(.96)	-
Constant	.074	-4.539	-.072	-5.276	.019	-5.379	.0120	-5.924
	(1.65)	-	(-1.30)	-	(.18)	-	(.26)	(-7.61)

Note: *, **, *** = significant at 0.10, 0.05 and 0.01 level.

Turning to Table 4, we replace the explanatory variable of inventory with inventory-sales ratio to circumvent the consistently increasing inventory level in line with the growing industry capacity. The response of linerboard price increase to previous one-month's inventory-sales ratio is still significant for both LPM and Probit models, lying in the range from –0.046 to –0.142 while the same spurious significance comes up with the probit model instead of the LPM model.

Table 5. Results on the price increase response to the inventory-capacity ratio

	Price Increase							
	Lag 1		Lag 2		Lag 3		Lag 4	
	LPM	Probit	LPM	Probit	LPM	Probit	LPM	Probit
Inventory/Capacity	-.082*	-.20***	-.138	-.15***	-.057	-.097*	-.029	-.058
	(-1.63)	(-2.69)	(-1.30)	(-2.72)	(-1.00)	(-1.71)	(-.53)	(-.89)
January	.033	5.392	.062	5.097	.074	5.107	.099	4.996
	(1.22)	(8.75)	(.54)	(6.10)	(.95)	(6.59)	(1.49)	(5.95)
February	.129	5.609	.275	5.474	.170	5.424	.157	5.212
	(1.47)	(9.66)	(1.98)	(6.33)	(1.83)	(6.82)	(1.97)	(5.95)
March	.296	6.356	.294	5.894	.320	6.004	.317	5.759
	(2.52)	(11.35)	(1.40)	(7.11)	(2.69)	(7.41)	(3.14)	(7.27)
April	.123	5.610	.159	5.521	.143	5.391	.167	5.269
	(1.50)	(9.70)	(1.01)	(6.10)	(1.60)	(6.78)	(2.14)	(6.23)
May	.007	-	.008	-	.006	-	.000	-
	(.42)	-	(.26)	-	(.37)	-	(.01)	-
June	.006	4.882	.044	4.782	.018	4.754	.036	4.637
	(.36)	(7.09)	(.81)	(5.25)	(.57)	(5.64)	(.85)	(5.05)
July	.147	5.795	.164	5.525	.176	5.621	.190	5.387
	(1.48)	(10.07)	(.91)	(6.76)	(1.77)	(6.95)	(2.24)	(6.81)
August	.026	5.356	.063	5.110	.073	5.121	.087	4.978
	(.76)	(8.71)	(.55)	(6.00)	(1.02)	(6.42)	(1.39)	(5.86)
September	.045	4.983	.252	4.831	.057	4.828	.063	4.603
	(1.97)	-	(5.88)	(5.29)	(2.21)	(5.52)	(1.45)	(5.25)
October	.2762	6.1582	.2791	5.8505	.2865	5.9250	.2938	5.7231
	(2.35)	(11.05)	(1.33)	(7.19)	(2.49)	(7.49)	(3.03)	(7.13)
November	.0053	4.8517	.0293	4.7594	.0254	4.7557	.0382	4.6029
	(.25)	(7.25)	(.63)	(5.32)	(.59)	(5.66)	(.89)	(5.23)
Constant	.1020	-4.220	.1628	-4.759	.0704	-5.382	.0343	-5.638
	(1.60)	(-4.40)	(1.28)	-	(.99)	-	(.53)	-

Note: *, **, *** = significant at 0.10, 0.05 and 0.01 level.

To confirm our finding as indicated in Table 4, we place the inventory-capacity ratio as the independent variable to explain the linerboard price increase. The response of linerboard price increase to previous one-month's inventory is keeping significant for both LPM and Probit models, lying in the range from –0.082 to –0.20 while simply the probit model points out that of linerboard price increase to previous two and three-month's inventory are significant.

Table 6. Results on the price decrease response to the absolute inventory level

	Price Decrease							
	Lag 1		Lag 2		Lag 3		Lag 4	
	LPM	Probit	LPM	Probit	LPM	Probit	LPM	Probit
Inventory	.881***	1.041***	.909***	1.071***	.885***	1.044***	.626***	.994***
	(5.14)	(6.90)	(5.27)	(6.84)	(5.13)	(6.96)	(3.38)	(6.87)
January	-.051	-.354	.010	.062	.055	.333	.027	.202
	(-.62)	(-.69)	(.12)	(.12)	(.66)	(.64)	(.31)	(.40)
February	-.144	-1.100	-.102	-.631	.006	.088	.011	.188
	(-1.38)	(-1.93)	(-.98)	(-1.15)	(.05)	(.17)	(.10)	(.36)
March	-.083	-.685	-.095	-.821	-.002	-.101	.065	.409
	(-.73)	(-1.30)	(-.89)	(-1.47)	(-.02)	(-.20)	(.57)	(.83)
April	-.027	-.441	-.035	-.515	.003	-.306	.073	.243
	(-.22)	(-.85)	(-.30)	(-.95)	(.03)	(-.58)	(.59)	(.50)
May	-.075	-.584	-.080	-.740	-.038	-.466	-.014	-.283
	(-.62)	(-1.12)	(-.67)	(-1.33)	(-.32)	(-.87)	(-.11)	(-.55)
June	-.050	-.264	-.078	-.561	-.033	-.410	-.008	-.251
	(-.39)	(-.53)	(-.62)	(-1.04)	(-.27)	(-.77)	(-.06)	(-.49)
July	-.051	-.234	-.053	-.314	-.032	-.303	-.005	-.225
	(-.42)	(-.47)	(-.45)	(-.60)	(-.28)	(-.58)	(-.04)	(-.44)
August	-.252	-1.467	-.203	-1.136	-.157	-.938	-.154	-.962
	(-2.17)	(-2.47)	(-1.87)	(-1.87)	(-1.48)	(-1.55)	(-1.37)	(-1.65)
September	-.319	-	-.356	-	-.258	-	-.236	-
	(-3.03)	-	(-3.49)	-	(-2.66)	-	(-2.30)	-
October	-.143	-.648	-.172	-.917	-.159	-.842	-.087	-.353
	(-1.31)	(-1.20)	(-1.67)	(-1.60)	(-1.55)	(-1.52)	(-.80)	(-.68)
November	-.099	-.453	-.145	-.686	-.126	-.645	-.123	-.644
	(-1.08)	(-.83)	(-1.66)	(-1.22)	(-1.48)	(-1.15)	(-1.36)	(-1.21)
Constant	-1.362	-10.870	-1.411	-11.070	-1.412	-10.560	-.944	-9.36
	(-4.47)	(-7.21)	(-4.60)	(-7.32)	(-4.42)	(-7.07)	(-2.70)	(-6.58)

Note: *, **, *** = significant at 0.10, 0.05 and 0.01 level.

Kindled by Holzer and Montogometry (1993) on the asymmetries and rigidities in wage adjustments, we also examine the response of linerboard price decrease to previous months' inventory level. As indicated in Table 6, it is found that the response of linerboard price decrease to previous one-month's inventory are significant for both LPM and Probit model, lying in the range from 0.881 to 1.041 that has a relatively larger magnitude than the response of price increase while that of price decrease to previous two, three and four-month's inventory level are unexpectedly significant for both models.

Table 7. Results on the price decrease response to the inventory-sales ratio

	Price Decrease							
	Lag 1		Lag 2		Lag 3		Lag 4	
	LPM	Probit	LPM	Probit	LPM	Probit	LPM	Probit
Inventory/Sales	.264*	.249**	.168	.290***	.223*	.267**	-.130	.164
	(1.79)	(2.38)	(.97)	(2.70)	(1.68)	(2.51)	(-.95)	(1.55)
January	-.062	-.215	-.017	-.098	.024	.106	.006	.019
	(-.79)	(-.48)	(-.20)	(-.22)	(.30)	(.24)	(.08)	(.04)
February	-.070	-.235	-.110	-.568	-.053	-.168	-.056	-.099
	(-.65)	(-.52)	(-1.03)	(-1.17)	(-.48)	(-.38)	(-.50)	(-.22)
March	-.030	-.112	-.031	-.184	-.055	-.258	.013	.011
	(-.26)	(-.26)	(-.27)	(-.41)	(-.48)	(-.56)	(.12)	(.02)
April	.051	.139	.011	-.089	.034	.082	.097	.019
	(.40)	(.33)	(.08)	(-.20)	(.26)	(.19)	(.68)	(.04)
May	-.023	-.110	-.019	-.144	-.031	-.153	.020	-.046
	(-.17)	(-.25)	(-.15)	(-.33)	(-.24)	(-.35)	(.14)	(-.10)
June	.009	.011	-.035	-.227	-.006	-.039	.020	-.094
	(.06)	(.02)	(-.24)	(-.51)	(-.04)	(-.09)	(.14)	(-.22)
July	-.009	-.041	-.014	-.095	-.026	-.114	.005	-.029
	(-.07)	(-.10)	(-.11)	(-.22)	(-.20)	(-.26)	(.04)	(-.07)
August	-.184	-.747	-.176	-.795	-.150	-.640	-.132	-.698
	(-1.46)	(-1.51)	(-1.38)	(-1.59)	(-1.25)	(-1.29)	(-1.06)	(-1.41)
September	-.238	-	-.292	-	-.265	-	-.248	-
	(-2.11)	-	(-2.35)	-	(-2.41)	-	(-2.24)	-
October	-.091	-.360	-.112	-.468	-.136	-.537	-.089	-.417
	(-.81)	(-.78)	(-1.00)	(-1.01)	(-1.23)	(-1.15)	(-.81)	(-.90)
November	-.067	-.287	-.115	-.475	-.097	-.374	-.077	-.476
	(-.67)	(-.62)	(-1.16)	(-1.02)	(-1.03)	(-.81)	(-.79)	(-1.02)
Constant	-.113	-1.857	.038	-1.946	-.049	-1.922	.422	-1.42
	(-.50)	(-3.16)	(.17)	(-3.43)	(-.25)	(-3.27)	(2.03)	(-2.48)

Note: *, **, *** = significant at 0.10, 0.05 and 0.01 level.

Applying the same approach as the price increase, we substitute the explanatory inventory-sales ratio for the inventory. As shown in Table 7, the response of linerboard price decrease to previous one-month's inventory-sales ratio is consistently significant for both LPM and Probit models, lying in the range from 0.249 to 0.264 that also has a relatively larger magnitude than the response of price increase. Different from the results by using the absolute inventory level, the response of linerboard price decrease to previous two-month's inventory-sales ratio is only significant for the probit model while that to previous three-month's inventory-sales ratio is marginally significant for LPM model and significant for probit model.

Table 8. Results on the price decrease response to the inventory-capacity ratio

	Price Decrease							
	Lag 1		Lag 2		Lag 3		Lag 4	
	LPM	Probit	LPM	Probit	LPM	Probit	LPM	Probit
Inventory/Capacity	.388	.290*	.356	.343**	.252	.303**	.012	.227
	(1.48)	(1.81)	(1.24)	(2.08)	(1.13)	(1.85)	(.05)	(1.40)
January	-.023	-.046	-.011	-.021	.022	.010	.004	-.004
	(-30)	(-.10)	(-.14)	(-.05)	(.26)	(.23)	(.05)	(-.01)
February	-.057	-.201	-.087	-.284	-.040	-.107	-.046	-.115
	(-.54)	(-.45)	(-.86)	(-.62)	(-.36)	(-.24)	(-.41)	(-.26)
March	-.044	-.130	-.020	-.079	-.006	-.010	.006	.030
	(-.38)	(-.30)	(-.18)	(-.18)	(-.05)	(-.02)	(.06)	(.07)
April	.047	.128	-.004	-.041	.055	.161	.056	.133
	(.36)	(.30)	(-.03)	(-.09)	(.43)	(.38)	(.42)	(.31)
May	-.028	-.099	-.017	-.084	-.020	-.107	-.000	-.032
	(-.21)	(-.23)	(-.13)	(-.19)	(-.15)	(-.24)	(-.00)	(-.07)
June	-.002	-.024	-.040	-.154	.007	.007	-.001	-.104
	(-.02)	(-.06)	(-.28)	(-.35)	(.05)	(.02)	(-.01)	(-.24)
July	-.013	-.044	-.016	-.062	-.010	-.049	.000	-.018
	(-.10)	(-.10)	(-.12)	(-.14)	(-.07)	(-.11)	(.00)	(-.04)
August	-.166	-.677	-.176	-.727	-.143	-.604	-.150	-.690
	(-1.34)	(-1.37)	(-1.42)	(-1.46)	(-1.18)	(-1.23)	(-1.21)	(-1.39)
September	-.247	-	-.279	-	-.250	-	-.250	-
	(-2.20)	-	(-2.43)	-	(-2.26)	-	(-2.26)	-
October	-.111	-.410	-.112	-.422	-.103	-.389	-.010	-.402
	(-.99)	(-.89)	(-1.01)	(-.92)	(-.93)	(-.85)	(-.91)	(-.87)
November	-.084	-.336	-.125	-.463	-.090	-.339	-.100	-.411
	(-.86)	(-.73)	(-1.27)	(-1.00)	(-.94)	(-.74)	(-1.05)	(-.89)
Constant	-.182	-1.787	-.132	-1.945	-.039	-1.866	.236	-1.54
	(-.60)	(-2.59)	(-.42)	(-2.83)	(-.15)	(-2.60)	(.82)	(-2.23)

Note: *, **, *** = significant at 0.10, 0.05 and 0.01 level.

To reassure our results from the estimation by using the absolute inventory level and the relative inventory-sales ratio as the explanatory variables, we apply the relative inventory-capacity ratio to estimate the linerboard price decrease in Table 8. The results turn out to be that only in the probit model the response of linerboard price decrease to previous one-month's inventory-capacity ratio is significant with the marginal effect of 0.290 that still has a larger magnitude than corresponding response of price increase while the similar scenarios take place for the response of linerboard price decrease to previous two and three-month's inventory-capacity ratio.

Table 9. Results on the output increase response to the absolute inventory level

	Output Increase							
	Lag 1		Lag 2		Lag 3		Lag 4	
	LPM	Probit	LPM	Probit	LPM	Probit	LPM	Probit
Inventory	-.038	-.115	.040	.114	.075	.153	.092	.157
	(-.44)	(-.51)	(.43)	(.51)	(.79)	(.73)	(.95)	(.77)
January	.233	.625	.229	.607	.233	.627	.231	.618
	(1.41	(1.51)	(1.39)	(1.48)	(1.40)	(1.52)	(1.39)	(1.50)
February	-.345	-1.137	-.347	-1.148	-.340	-1.111	-.336	-1.082
	(-2.53)	(-2.38)	(-2.52)	(-2.39)	(-2.47)	(-2.32)	(-2.43)	(-2.28)
March	.553	-	.546	-	.548	-	.558	-
	(4.71)	-	(4.64)	-	(4.66)	-	(4.72)	-
April	-.447	-	-.454	-	-.454	-	-.451	-
	(-3.88)	-	(-3.95)	-	(-3.95)	-	(-3.93)	-
May	.403	1.190	.397	1.135	.397	1.146	.398	1.157
	(2.87)	(2.66)	(2.82)	(2.55)	(2.81)	(2.59)	(2.82)	(2.61)
June	-.298	-.887	-.303	-.945	-.303	-.940	-.301	-.930
	(-2.17)	(-2.00)	(-2.23)	(-2.10)	(-2.23)	(-2.10)	(-2.21)	(-2.08)
July	-.048	-.112	-.052	-.144	-.053	-.143	-.051	-.133
	(-.29)	(-.28)	(-.32)	(-.36)	(-.33)	(-.36)	(-.32)	(-.33)
August	.205	.547	.198	.493	.199	.507	.200	.508
	(1.31)	(1.34)	(1.26)	(1.22)	(1.26)	(1.26)	(1.26)	(1.26)
September	-.447	-	-.455	-	-.451	-	-.448	-
	(-3.76)	-	(-3.81)	-	(-3.79)	-	(-3.76)	-
October	.152	.392	.147	.358	.145	.355	.152	.389
	(.96)	(.98)	(.93)	(.89)	(.92)	(.89)	(.97)	(.97)
November	-.450	-	-.452	-	-.452	-	-.453	-
	(-3.73)	-	(-3.76)	-	(-3.75)	-	(-.3.76)	-
Constant	.520	.404	.378	-.651	.308	-.847	.275	-.877
	(2.64)	(.37)	(1.86)	(-.61)	(1.46)	(-.82)	(1.27)	(-.87)

Note: *, **, *** = significant at 0.10, 0.05 and 0.01 level.

Table 10. Results on the output increase response to the inventory-sales ratio

	Output Increase							
	Lag 1		Lag 2		Lag 3		Lag 4	
	LPM	Probit	LPM	Probit	LPM	Probit	LPM	Probit
Inventory/Sales	-.065	-.066	.007	.065	-.025	-.050	-.023	-.037
	(-.92)	(-.42)	(.09)	(.39)	(-.34)	(-.27)	(-.35)	(-.18)
January	.245	.645	.228	.585	.227	.595	.229	.608
	(1.47)	(1.53)	(1.37)	(1.41)	(1.37)	(1.44)	(1.39)	(1.48)
February	-.338	-1.110	-.346	-1.207	-.343	-1.112	-.345	-1.13
	(-2.48)	(-2.31)	(-2.65)	(-2.30)	(-2.50)	(-2.32)	(-2.50)	(-2.4)
March	.557	-	.548	-	.557	-	.551	-
	(4.80)	-	(4.59)	-	(4.68)	-	(4.72)	-
April	-.450	-	-.452	-	-.449	-	-.444	-
	(-3.98)	-	(-3.91)	-	(-3.94)	-	(-3.87)	-
May	.406	1.178	.399	1.143	.404	1.180	.397	1.14
	(2.90)	(2.65)	(2.83)	(2.57)	(2.87)	(2.63)	(2.77)	(2.53)

June	-.302	-.917	-.302	-.943	-.299	-.909	-.297	-.90
	(-2.23)	(-2.06)	(-2.17)	(-2.10)	(-2.19)	(-2.05)	(-2.16)	(-2.0)
July	-.048	-.122	-.051	-.142	-.047	-.113	-.049	-.12
	(-.30)	(-.30)	(-.31)	(-.36)	(-.29)	(-.28)	(-.31)	(-.31)
August	.209	.534	.199	.487	.200	.511	.203	.523
	(1.33)	(1.31)	(1.25)	(1.20)	(1.27)	(1.27)	(1.29)	(1.28)
September	-.453	-	-.452	-	-.448	-	-.450	-
	(-3.85)	-	(-3.77)	-	(-3.80)	-	(-3.81)	-
October	.148	.376	.149	.365	.154	.401	.152	.387
	(.95)	(.94)	(.95)	(.91)	(.98)	(.98)	(.97)	(.96)
November	-.458	-	-.451	-	-.450	-	-.446	-
	(-3.82)	-	(-3.74)	-	(-3.76)	-	(-3.73)	-
Constant	.539	.101	.441	-.328	.484	.041	.480	-.00
	(3.53)	(.17)	(2.83)	(-.56)	(3.16)	(.06)	(3.28)	(-.00)

Note: *, **, *** = significant at 0.10, 0.05 and 0.01 level.

Table 11. Results on the output increase response to the inventory-capacity ratio

	Output Increase							
	Lag 1		Lag 2		Lag 3		Lag 4	
	LPM	Probit	LPM	Probit	LPM	Probit	LPM	Probit
Inventory/Capacity	-.167	-.259	-.051	.016	-.117	-.250	-.096	-.162
	(-1.54)	(-1.07)	(-.42)	(.06)	(-1.03)	(-.98)	(-.91)	(-.57)
January	.242	.654	.231	.604	.221	.568	.233	.625
	(1.47)	(1.58)	(1.40)	(1.47)	(1.35)	(1.37)	(1.42)	(1.51)
February	-.346	-1.132	-.338	-1.134	-.347	-1.117	-.347	-1.127
	(-2.57)	(-2.39)	(-2.52)	(-2.31)	(-2.50)	(-2.36)	(-2.51)	(-2.37)
March	.570	-	.553	-	.554	-	.551	-
	(4.93)	-	(4.72)	-	(4.77)	-	(4.74)	-
April	-.447	-	-.442	-	-.452	-	-.445	-
	(-4.00)	-	(-3.86)	-	(-4.01)	-	(-3.94)	-
May	.413	1.222	.403	1.160	.410	1.215	.402	1.169
	(2.98)	(2.72)	(2.86)	(2.61)	(2.93)	(2.71)	(2.87)	(2.64)
June	-.298	-.909	-.294	-.915	-.303	-.931	-.289	-.868
	(-2.22)	(-2.04)	(-2.14)	(-2.04)	(-2.24)	(-2.08)	(-2.12)	(-1.93)
July	-.043	-.103	-.047	-.130	-.045	-.103	-.049	-.122
	(-.27)	(-.26)	(-.29)	(-.32)	(-.28)	(-.25)	(-.30)	(-.31)
August	.209	.547	.204	.508	.197	.499	.208	.543
	(1.33)	(1.35)	(1.29)	(1.25)	(1.26)	(1.24)	(1.32)	(1.34)
September	-.450	-	-.446	-	-.449	-	-.449	-
	(-3.86)	-	(-3.77)	-	(-3.85)	-	(-3.83)	-
October	.156	.409	.152	.377	.152	.394	.154	.399
	(1.02)	(1.01)	(.97)	(.94)	(.98)	(.98)	(.99)	(.99)
November	-.456	-	-.446	-	-.454	-	-.445	-
	(-3.87)	-	(-3.73)	-	(-3.85)	-	(-3.75	-
Constant	.634	.592	.504	-.168	.583	.587	.556	.321
	(3.77)	(.81)	(2.91)	(-.23)	(3.34)	(.72)	(3.36)	(.39)

Note: *, **, *** = significant at 0.10, 0.05 and 0.01 level.

Table 12. Results on the output decrease response to the absolute inventory level

	Output Decrease

	Lag 1		Lag 2		Lag 3		Lag 4	
	LPM	Probit	LPM	Probit	LPM	Probit	LPM	Probit
Inventory	.104	.228	-.013	-.012	-.121	-.207	-.180	-.292
	(.94)	(1.08)	(-.11)	(-.05)	(-1.03)	(-1.02)	(-1.44)	(-1.48)
January	-.304	-1.288	-.297	-1.234	-.304	-1.266	-.303	-1.266
	(-2.46)	(-2.29)	(-2.40)	(-2.22)	(-2.44)	(-2.27)	(-2.42)	(-2.26)
February	.490	1.369	.493	1.391	.486	1.375	.477	1.346
	(3.56)	(3.05)	(3.54)	(3.07)	(3.49)	(3.03)	(3.42)	(2.96)
March	-.359	-	-.349	-	-.348	-	-.365	-
	(-3.25)	-	(-3.16)	-	(-3.17)	-	(-3.30)	-
April	.542	1.648	.551	1.669	.556	1.682	.543	1.613
	(4.15)	(3.41)	(4.19)	(3.48)	(4.22)	(3.54)	(4.08)	(3.38)
May	-.358	-	-.349	-	-.345	-	-.346	-
	(-3.24)	-	(-3.17)	-	(-3.14)	-	(-3.14)	-
June	-.006	-.034	.001	.003	.004	.018	.002	.006
	(-.04)	(-.08)	(.01)	(.01)	(.03)	(.04)	(.01)	(.02)
July	-.056	-.163	-.049	-.138	-.046	-.131	-.049	-.156
	(-.36)	(-.40)	(-.32)	(-.33)	(-.30)	(-.32)	(-.33)	(-.37)
August	-.162	-.546	-.149	-.454	-.149	-.438	-.149	-.433
	(-1.16)	(-1.23)	(-1.05)	(-1.05)	(-1.03)	(-1.02)	(-1.03)	(-1.01)
September	.392	1.017	.402	1.064	.401	1.073	.396	1.060
	(2.64)	(2.42)	(2.72)	(2.50)	(2.73)	(2.55)	(2.71)	(2.51)
October	-.305	-1.283	-.299	-1.258	-.292	-1.238	-.304	-1.301
	(-2.50)	(-2.33)	(-2.46)	(-2.27)	(-2.42)	(-2.22)	(-2.53)	(-2.32)
November	.450	1.236	.451	1.228	.454	1.248	.457	1.265
	(3.12)	(2.87)	(3.11)	(2.85)	(3.14)	(2.89)	(3.16)	(2.92)
Constant	.160	-1.444	.373	-.332	.578	.602	.693	1.028
	(.69)	(-1.41)	(1.59)	(-.32)	(2.33)	(.59)	(2.63)	(1.03)

Note: *, **, *** = significant at 0.10, 0.05 and 0.01 level.

Table 13. Results on the output decrease response to the inventory-sales ratio

	Output Decrease							
	Lag 1		Lag 2		Lag 3		Lag 4	
	LPM	Probit	LPM	Probit	LPM	Probit	LPM	Probit
Inventory/Sales	.235***	.395**	.124	.166	.105	.201	.059	.081
	(2.77)	(2.38)	(1.16)	(1.08)	(1.14)	(1.14)	(.68)	(.49)
January	-.356	-1.566	-.313	-1.285	-.289	-1.184	-.298	-1.233
	(-2.82)	(-2.61)	(-2.52)	(-2.29)	(-2.39)	(-2.12)	(-2.43)	(-2.21)
February	.472	1.320	.446	1.218	.488	1.361	.496	1.401
	(3.48)	(2.89)	(3.20)	(2.58)	(3.52)	(3.02)	(3.57)	(3.10)
March	-.376	-	-.376	-	-.380	-	-.353	-
	(-3.62)	-	(-3.39)	-	(-3.34)	-	(-3.25)	-
April	.551	1.738	.521	1.593	.533	1.613	.527	1.590
	(4.54)	(3.52)	(3.95)	(3.26)	(4.08)	(3.29)	(3.84)	(3.23)
May	-.371	-	-.365	-	-.365	-	-.357	-
	(-3.59)	-	(-3.37)	-	(-3.34)	-	(-3.24)	-
June	.007	.039	-.026	-.087	-.003	-.007	-.009	-.029
	(.05)	(.09)	(-.17)	(-.21)	(-.02)	(-.02)	(-.06)	(-.07)
July	-.059	-.193	-.062	-.180	-.063	-.203	-.052	-.145
	(-.42)	(-.45)	(-.42)	(-.43)	(-.42)	(-.48)	(-.35)	(-.35)
August	-.182	-.583	-.170	-.512	-.150	-.444	-.158	-.477
	(-1.31)	(-1.32)	(-1.18)	(-1.18)	(-1.06)	(-1.03)	(-1.09)	(-1.10)

September	.410	1.129	.368	.959	.393	1.033	.399	1.060
	(2.89)	(2.64)	(2.46)	(2.23)	(2.68)	(2.45)	(2.72)	(2.52)
October	-.293	-1.222	-.310	-1.283	-.317	-1.341	-.305	-1.270
	(-2.57)	(-2.19)	(-2.60)	(-2.31)	(-2.62)	(-2.39)	(-2.52)	(-2.29)
November	.479	1.367	.439	1.197	.451	1.239	.440	1.191
	(3.33)	(3.10)	(3.04)	(2.76)	(3.15)	(2.87)	(3.02)	(2.73)
Constant	.029	-1.782	.196	-.920	.209	-1.08	.272	-.665
	(.20)	(-2.70)	(1.22)	(-1.60)	(1.37)	(-1.59)	(1.89)	(-1.03)

Note: *, **, *** = significant at 0.10, 0.05 and 0.01 level.

Table 14. Results on the output decrease response to the inventory-capacity ratio

	Output Decrease							
	Lag 1		Lag 2		Lag 3		Lag 4	
	LPM	Probit	LPM	Probit	LPM	Probit	LPM	Probit
Inventory/Capacity	.321***	.578**	.172	.249	.153	.275	.078	.108
	(2.65)	(2.24)	(1.18)	(1.05)	(1.15)	(1.06)	(.60)	(.43)
January	-.320	-1.375	-.305	-1.257	-.287	-1.180	-.301	-1.242
	(-2.62)	(-2.40)	(-2.48)	(-2.25)	(-2.40)	(-2.10)	(-2.43)	(-2.23)
February	.494	1.412	.473	1.310	.496	1.404	.494	1.395
	(3.71)	(3.13)	(3.41)	(2.89)	(3.59)	(3.11)	(3.56)	(3.09)
March	-.388	-	-.360	-	-.356	-	-.351	-
	(-3.66)	-	(-3.33)	-	(-3.31)	-	(-3.24)	-
April	.546	1.719	.523	1.595	.552	1.707	.539	1.628
	(4.47)	(3.48)	(3.96)	(3.27)	(4.42)	(3.51)	(4.08)	(3.36)
May	-.375	-	-.359	-	-.363	-	-.351	-
	(-3.59)	-	(-3.34)	-	(-3.35)	-	(-3.24)	-
June	-.004	-.006	-.020	-.070	.003	.024	-.009	-.030
	(-.03)	(-.01)	(-.13)	(-.17)	(.02)	(.06)	(-.06)	(-.07)
July	-.063	-.211	-.059	-.173	-.057	-.169	-.051	-.141
	(-.45)	(-.49)	(-.40)	(-.41)	(-.38)	(-.40)	(-.34)	(-.34)
August	-.166	-.514	-.164	-.496	-.147	-.426	-.156	-.472
	(-1.20)	(-1.17)	(-1.15)	(-1.14)	(-1.05)	(-.98)	(-1.08)	(-1.09)
September	.400	1.086	.385	1.010	.399	1.063	.399	1.057
	(2.80)	(2.55)	(2.61)	(2.39)	(2.73)	(2.52)	(2.71)	(2.52)
October	-.311	-1.316	-.307	-1.279	-.302	-1.266	-.303	-1.266
	(-2.70)	(-2.34)	(-2.58)	(-2.30)	(-2.57)	(-2.27)	(-2.52)	(-2.29)
November	.462	1.314	.437	1.191	.455	1.261	.446	1.215
	(3.27)	(2.99)	(3.03)	(2.75)	(3.20)	(2.91)	(3.09)	(2.82)
Constant	-.004	-2.032	.166	-1.068	.176	-1.194	.263	-.693
	(-.03)	(-2.55)	(.94)	(-1.50)	(1.04)	(-1.46)	(1.60)	(-.90)

Note: *, **, *** = significant at 0.10, 0.05 and 0.01 level.

From Table 9 to Table 14, we can see, different from the linerboard price behavior, the response of output increase is indifferent to the absolute inventory level, the relative inventory-sales ratio, and the relative inventory-capacity ratio while only the responses of output decrease to the previous one-month's inventory-sales ratio and inventory-capacity ratio are significant, lying in the range from 0.235 to 0.395 and the range from 0.321 to 0.578 respectively.

As discussed above, the observed pattern of U.S. linerboard price behavior can be predicated by the preceding month's absolute inventory level, relative inventory-sales ratio, and relative inventory-capacity ratio. Comparing the response of linerboard price increase to those inventory related variables ranging from –0.046 to –0.20 and that of price decrease to those variables ranging from 0.249 to 1.041, we can find that the asymmetries in price response behavior is consistent to the presumed oligopolistic market condition of U.S. paper and paperboard. As an oligopolistic coordination market, all the incumbents are willing to cut down the selling price during the negative business climate or excessive inventory period to protect their existent market share. Conversely, they are cautious to raise the selling price even the industry is confronting the positive climate or short of inventory that results the "sticker" and rigid price increase because it is likely that some members in the coordination will cheat in the price collusion by keeping the original price to steal the market share from ones executing the price increase.

We also find that the relative inventory-sales ratio or inventory-capacity may be a better estimator for the response of U.S. linerboard price behavior than the absolute inventory level. The absolute inventory level is considerably influenced by the growing industry production and capacity level, which amplified the effect on the probability of price change.

In contrast to the response of price change, we do not find any strong evidence to suggest that there are significant output response to those previous period's absolute inventory level and relative inventory ratios. That supports many firms are hesitated to bring down their production level even in an unfavorable business climate because the deep sunk cost and high fixed cost in the U.S. paper and paperboard industry make them hard to shun down their excessive mills and plants.

5. CONCLUSIONS

In this paper, a simple econometric model is developed and monthly data from January 1980 to December 1999 are collected to investigate the effect of absolute inventory level and relative inventory ratios on the probability of price response and output response. We find that the price response of U.S. linerboard industry to the preceding month's inventory variables are significant and asymmetric, the probability of downward price adjustment outweighs that of upward price adjustment due to the oligopolistic nature of U.S. linerboard industry. Beyond the observed pattern of price behavior, we do not find similar evidence to support the output response of the industry. Finally, we also find in the estimation LPM model, after correcting the heteroskedasticity and serial correlation, outperforms the probit model that consistently overstates the marginal effect and statistical significance.

REFERENCES

Aguirregabiria, Victor. (1999) “The Dynamics of Markups and Inventories in Retailing Firms.” *Review of Economic Studies* 66, 275-308.

Amihud, Yakov and Mendelson, Haim. (1982) “Relative Price Dispersion and Economic Shocks.” Journal of Money, Credit, and Banking 14, 390-98.

Blinder, Alan S. (1983) “Inventories and Sticky Prices: More on the Microfoundations of Macroeconomics.” American Economic Review 72, 334-48.

Booth, D.L., Kanetkar, V., Vertinsky, I., and Whistler, D. (1991) “An Empirical Model of Capacity Expansion and Pricing Oligopoly with Barometric Price Leadership: A Case Study of the Newsprint Industry in North America.” Journal of Industry Economics 39, 255-76.

Buongiorno, J. and Lu, H.C. (1989) “Effects of Costs, Demand, and Labor Productivity on the Prices of Forest Products in the United States, 1958-1984.” Forest Science 35, 349-63.

Christensen, Laurits Rolf and Caves, Richard E. (1997)“Cheap Talk and Investment Rivalry in the Pulp and Paper Industry.” Journal of Industry Economics 45, 47-73.

Dagenais, Marcel G. (1976) “The Determination of Newsprint Prices.” Canadian Journal of Economics 9, 442-61.

Darling, P. and Lovell, M. (1965) “Factors Influencing Investment in Inventories.” The Brookings Quarterly Econometric Model of the U.S., Chicago.

Eckstein, O. and Fromm, G. (1968) “The Price Equation.” American Economic Review 58, 1159-83.

Hay, George A. (1970) “Production, Price and Inventory Theory.” American Economic Review 60, 531-45.

Holzer, Harry J. and Montgomery, Edward B. (1993) “Asymmetries and Rigidities in Wage Adjustments by Firms.” The Review of Economics and Statistics 75, 397-408.

Maccini, Louis J. (1976) “An Aggregate Dynamic Model of Short-Run Price and Output Behavior.” Quarterly Journal of Economics 90, 177-96.

McCallum, B.T. (1974) “Competitive Price Adjustment: An Empirical Study.” American Economic Review 64, 56-65.

Muller, R.A. (1978) “Econometric Analysis of Environmental Policy: Estimation of a Model of the Canadian Pulp and Paper Industry.” Canadian Journal of Economics 11, 263-86.